FLEXIBLE CONTAINER

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BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a flexible container, particularly a flexible container having a seal with non-linear seal portions, wherein forces exerted on the seal by fluid materials contained within the flexible container are more evenly distributed along the seal, and forming an extended opening for easy access to a void without increasing the overall width of the flexible container.

Description of Related Art

Under new Federal Aviation Administration (FAA), in the United States, testing criteria in the United States, a container must be able to withstand a sustained internal pressure of about 14 psi for at least about 30 minutes in order to be suitable for transporting toxic and other hazardous materials, using air transportation. For example, if an airplane traveling at an elevation of about 42,000 feet is depressurized, the container must withstand a net effect of an internal pressure of about 14 psi in order to remain sealed. Many conventional containers, particularly flexible containers, cannot withstand such high internal pressure. As a result, a conventional flexible container leaks through a closure which sealably closes a container opening, breaks at a weak peripheral seal or deforms or expands at a region and develops an opening, whereby the materials contained within the container leak from the container.

For example, it is very difficult to provide a flexible container that can withstand high internal pressures and maintain a leak-proof closure. Conventional

flexible containers typically have a general rectangular void area when in a flat or uninflated condition. The seal which forms the void is positioned about a periphery of the flexible container and includes a bottom portion, a top portion and opposing side edge portions. The seal portions are generally linear or straight. As a result, when the flexible container is inflated or filled with a fluid material and subjected to increased internal pressure, forces exerted on the side walls and the seal cause a center of the seal portions to be pulled inward toward the void, thus causing the seals to form an hour-glass shaped void. This causes even greater forces to be exerted on the seal which may result in failure of the seal at a weak portion of the seal or closure area and leakage of the material contained within the flexible container, particularly when the flexible container is subjected to a high internal pressure.

There is an apparent need for a flexible container wherein forces exerted by the material contained within the flexible container on the seal are reduced and/or more evenly distributed along the seal.

There is also an apparent need for a flexible container wherein portions of the seal are generally linear when filled with a fluid material.

There is also an apparent need for a flexible container which provides an increased opening for placing material within the flexible container without increasing the overall width of the flexible container.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a flexible container having a seal with non-linear seal portions when in a flat or uninflated condition, to more evenly distribute forces exerted on the seal when fluid materials are contained within the flexible container.

It is another object of this invention to provide a flexible container that provides an increased opening to provide access to the void formed by the flexible container while providing seal portions which distribute forces more evenly along the seal.

The above and other objects of this invention are accomplished with a flexible container having at least two webs positioned and sealed with respect to each other about a periphery of the flexible container, to form a void between the webs. In one preferred embodiment of this invention, the first web and/or the second web includes two or more layers of material. For example, the first web may include a first or outer layer made of a polymer material, such as a polyester or nylon or other similar material, and a second or inner sealant layer made of a polymer material, such as a polyethylene material. Similarly, the second web may include a first layer and a second layer. Preferably, but not necessarily, the first layer of the second web includes a material the same or similar to the first layer of the first web and the second layer comprises a material the same or similar to the second layer of the first web. Alternatively, the first layer and the second layer of the second web may include a

different material than the first layer and the second layer of the first web, respectively.

At least one seal joins or seals the first web with respect to the second web and forms the void between the webs. The seal is preferably formed about a periphery of the flexible container using any suitable sealing process, for example a heat sealing process and/or an adhesive sealing process. It should be apparent to those skilled in the art that other suitable sealing processes may be used to form the seal. Additional seals may be formed and positioned with respect to the void. For example, a second seal, continuous or segmented, can be formed within the primary seal to maintain the void in a proper configuration or shape.

Preferably, at least one seal is continuous and at least an inner edge of at least one portion of the seal is non-linear. In one embodiment of this invention, an inner edge of at least one portion of the seal has an arcuate shape. For example, an inner edge of at least one of a bottom portion, a top portion and/or opposing side edge portions of the seal has an arcuate shape. Preferably, the arcuate-shaped inner edge of the portion or portions of the seal are bowed outward from the void.

In one preferred embodiment of this invention, the inner edge of the bottom portion of the seal is bowed outward from the void. Preferably, the inner edge of the bottom portion follows an arc segment wherein a height of the arc segment, as defined below, is at least about 0.125 inch. Additionally or alternatively, at least a portion of the inner edge of at least one opposing side edge portion is bowed outward

from the void, in a direction from a top to a bottom of the respective opposing side edge portion. Similarly, the non-linear or arcuate inner edge of opposing side edge portions of the seal follow an arc segment wherein a height of the arc segment is at least about 0.125 inch. In one preferred embodiment of this invention, the opposing side edge portions converge in a direction toward the bottom portion of the seal. Additionally, near a closure area formed or defined by the flexible container, at least the inner edge of the opposing side edge portions of the seal may diverge from each other in a direction from the bottom to the top of the side edge portions to provide a large or extended opening in the closure area. An inner edge of the top portion of the seal may also be non-linear, for example arcuate. The inner edge of the top portion may be bowed outward from the void. Preferably, the inner edge of the top portion follows an arc segment wherein a height of the arc segment is at least about 0.125 inch.

The flexible container also includes a closure area defined by the first web. The closure area forms an opening which provides access to the void. In one preferred embodiment of this invention, the opening includes a slit positioned along a fold line that passes through the closure area. Preferably, but not necessarily, at least one of the first web and the second web has a structural relief near at least one of opposing end portions of the slit. The structural relief includes at least one layer of at least one of the first web and the second web having a reduced thickness at the fold line. A layer of adhesive is applied to the first web at the closure area to provide

a tight leak-proof seal about the opening when a top portion of the flexible container is folded along the fold line with respect to a bottom portion of the flexible container and about the opening.

Other objects and advantages of this invention will be apparent to those skilled in the art from the following detailed description taken in conjunction with the appended claims and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings show different features of a flexible container, according to preferred embodiments of this invention, wherein:

Fig. 1 is a front view of a flexible container in a flat or unfolded condition, according to one preferred embodiment of this invention;

Fig. 2 is a cross-sectional side view of the flexible container taken along sectional line A-A as shown in Fig. 1;

Fig. 3 is a front view of a flexible container in a flat or unfolded condition, according to another preferred embodiment of this invention;

Fig. 4 is a front view of a flexible container in a flat or unfolded condition, according to another preferred embodiment of this invention;

Fig. 5 is a front view of a flexible container in a flat and unfolded condition, showing an arc segment of an arcuate seal portion, according to another preferred embodiment of this invention;

Fig. 6 is a front view of a flexible container in a flat or unfolded condition, according to another preferred embodiment of this invention;

Fig. 7 is a front view of a flexible container having a seal forming a generally circular void, in a flat or empty condition;

Fig. 8 is a front view of a flexible container having a seal forming a generally circular void, and showing forces exerted on the seal when the flexible container is filled with a fluid material and subjected to an increased internal pressure;

Fig. 9 is a side view of a flexible container having a seal forming a generally circular void, in a flat or empty condition;

Fig. 10 is a side view of a flexible container having a seal forming a generally circular void, filled with a fluid material and subjected to an increased internal pressure;

Fig. 11 is a front view of a conventional flexible container having a seal forming a generally rectangular void, in a flat or empty condition;

Fig. 12 is a front view of a conventional flexible container having a seal forming a generally rectangular void, and showing forces exerted on the seal when the conventional flexible container is filled with a fluid material and subjected to an increased internal pressure;

Fig. 13 is a side view of a conventional flexible container having a seal forming a generally rectangular void, in a flat or empty condition; and

Fig. 14 is a side view of a conventional flexible container having a seal forming a generally rectangular void, filled with a fluid material and subjected to an increased internal pressure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to Figs. 1-6, a flexible container 10 comprises a first web of material 20 and a second web of material 40, one on each side of flexible container 10, joined and/or sealed with respect to each other to form a void 28 between webs 20, 40. In other preferred embodiments of this invention, each web 20, 40 may comprise more than one layer of material and either side of flexible container 10 can include two or more webs 20, 40.

The term "flexible" refers to the ability of flexible container 10 to bend, stretch, expand or contract, for example, without permanent deformation or failure, to adapt to changing environments, for example a change in pressure or change in temperature. It is apparent that flexible container 10 and/or void 28 formed between webs 20, 40 can have any suitable shape and/or dimensions which allows flexible container 10 to function properly for a particular purpose. Flexible container 10 may comprise at least one component or element similar to a corresponding component or element as taught in United States Patent 5,336,123 issued to Laske et al. on August 9, 1994 and/or as taught in copending, commonly owned United States Patent Application Serial No. 10/165,633, filed on 07 June 2002 naming Louis L. Laske as

the inventor, the disclosures of which are incorporated by reference into this specification.

Throughout this specification, as discussed above, one side of flexible container 10 may include one or more first webs 20 and the opposing side of flexible container 10 may comprise one or more second webs 40. As different elements and features are discussed throughout this specification, when referring to one first web 20 and/or one second web 40, such discussion can be interchanged with discussion related to either side of flexible 10 having two or more first webs 20 and/or two or more second webs 40.

In one preferred embodiment of this invention, each web 20, 40 has a total thickness of about 0.003 inch to about 0.010 inch and comprises at least two layers of material that are coextensive. The term "coextensive" as used throughout this specification and in the claims refers to the positioning of web 20 with respect to web 40, wherein web 20 is aligned with web 40 such that web 20 and web 40 generally have the same or similar outer boundaries, for example boundaries forming the edges of flexible container 10. In one preferred embodiment of this invention, first web 20 includes a first or outer layer made of a polymer material, such as a polyester or nylon or other similar material, having a thickness of about 0.00025 inch to about 0.0015 inch and a second or inner sealant layer made of a polymer material having a thickness of about 0.0005 inch to about 0.006 inch. The first layer may comprise a 0.00060 inch, for example, biaxial oriented nylon material, such as

available from Clear-Lam, located in Illinois, United States. The biaxial oriented nylon material provides a strong structure due to equal or similar tensile strengths in the longitudinal direction and the lateral direction of the material. Preferably, the second layer comprises a 0.0015 inch polyethylene material, such as available from Southern Films located in Florida, U.S.A., a material which is known as a linear low density polyethylene. Other suitable materials known to those skilled in the art may be used to make the first layer and/or the second layer of first web 20 and/or second web 40.

Similarly, second web 40 may include a first layer and a second layer. Preferably but not necessarily, the first layer comprises a material the same or similar to the first layer of first web 20 and the second layer comprises a material the same or similar to the second layer of first web 20. Alternatively, the first layer and the second layer may comprise a different material than the first layer and the second layer of first web 20, respectively. In one preferred embodiment of this invention, first web 20 and second web 40 each comprises a third layer sealed with respect to the first and second layers. For example, a third layer (not shown) made of 0.0015 inch polyethylene, for example, may be sealed with respect to the first layer to sandwich or position the first layer between the second layer and the third layer.

The first layers and the second layers, and any additional layers, may be made of any suitable compatible materials, for example polymer materials, which when combined to form one or more of each of webs 20, 40 exhibit a combined

strength capable of withstanding a wide pressure and/or temperature range. The multiple layer, multiple web construction of flexible container 10 provides a strong structure because one layer supports the other layer. Preferably, flexible container 10 is capable of withstanding a constant or sustained internal pressure of at least about 14 psi. The closure at closure area 62 and the corresponding material of the closure can withstand temperatures of about -40°F to about 130°F, without deformation of and/or leakage through the closure.

Preferably, first web 20 and second web 40 are heat sealed to form a seal 30 about a periphery of flexible container 10, as shown in Figs. 1, 3 and 4. Any other suitable process for sealing, as known to those skilled in the art, can be used to form one or more seals between webs 20, 40. In one preferred embodiment of this invention, seal 30 preferably has a width of at least about 0.125 inch, and more preferably at least about 0.375 inch, but in other embodiments can be larger or smaller depending upon the overall size of flexible container 10 and the material which flexible container 10 may contain. In another preferred embodiment of this invention, seal 30 can have a variable width and/or any other shape at any point or in any direction about the periphery of seal 30. It is apparent that other suitable bonding means, for example adhesives and the like, may be used to form seal 30 and attach or bond webs 20, 40. Flexible container 10 may comprise additional seals, as required. For example, if the side of flexible container 10 that has opening 60 has two or more first webs 20, then a seal 31 such as shown in Fig. 1 can be used to heat seal the two

or more first webs 20 together, wherein seal 31 surrounds or is below opening 60, as shown in Fig. 1. In another preferred embodiment of this invention, a seal 32 extends along at least a portion at or near a top edge and/or a bottom edge of flexible container 10 to seal first web 20 to second web 40.

Referring to Figs. 1-6, second web 40 is positioned with respect to first web 20 and webs 20, 40 are sealed to form void 28 between webs 20, 40. As discussed above, it is apparent that webs 20, 40 can be sealed using any suitable sealing process, such as a heat sealing process and/or an adhesive sealing process. Preferably, seal 30 is continuous and is formed about a periphery of flexible container 10. Void 28 formed between webs 20, 40 can have any suitable shape and/or dimensions which allows flexible container 10 to function properly for a particular purpose.

Preferably, at least an inner edge of at least one portion of seal 30 is non-linear. For example, referring to Figs. 1, 3 and 4, an inner edge of at least one portion of seal 30 has an arcuate shape. As shown in Fig. 1, an inner edge of a bottom portion 33, a first side edge portion 34 and/or a second side edge portion 35, opposing first side edge portion, has an arcuate shape. Further, at least an inner edge of a top portion 36 of seal 30 may be arcuate or otherwise non-linear. It is critical to the present invention that at least the inner edge of seal portion 33, 34, 35 and/or 36 is non-linear, for example having an arcuate shape. Seal 30, including an outer edge of seal portions 33, 34, 35 and 36, can have any suitable shape or configuration. For

example, as shown in Fig. 1, an inner edge of each of seal portions 33, 34, 35 has an arcuate shape, while an outer edge of seal portion 33, 34 and 35 is generally linear.

Referring to Figs. 7-10, seal portions having an inner edge with an arcuate shape in a flat or uninflated condition can better distribute pressure within void 28 because as a seal approaches a generally circular shape, forces exerted against the seal by materials contained within void 28 will be more evenly distributed about the seal. As shown in Figs. 7-10, a flexible container 100 having a seal 110 forming a void 120 having a generally circular shape can better distribute pressure within void 120 and against seal 110, when compared to a conventional flexible container 200 having a seal 210 forming a void 220 having a generally rectangular shape, as discussed above and shown in Figs. 11-14. Thus, the resultant stresses on seal 110 at all points about the seal periphery should be generally equal, and circular void 120 should remain circular, when filled with a fluid material and subjected to an increased internal pressure, as shown in Fig. 8. Conversely, as shown in Fig. 12, when conventional flexible container 200 having rectangular shaped void 220 is filled with a fluid material and subjected to an increased internal pressure, center portions of seal 210 are pulled inward toward void 220, thus causing seal 210 to form an hour-glass shaped void. Such deformation can result in seal failure and leakage of the material contained within void 220.

Preferably, but not necessarily, each arcuate-shaped portion of seal 30 is bowed outward from void 28. Referring to Figs. 1 and 5, the inner edge of bottom

portion 33 of seal 30 is bowed outward from void 28. As shown in Figs. 1 and 3-6, the inner edge of bottom portion 33 follows an arc segment and a height of the arc segment is at least about 0.125 inch. The term "arc segment" as used throughout this specification and in the claims refers to a curved or arcuate portion of seal 30. Referring further to Fig. 5, an arc segment *s* has a length determined between two points of intersection between a chord *c* and an inner edge of arcuate-shaped seal portion 33. The height *h* of arc segment *s* can be defined as the difference between a radius *r* of a circle including arc segment *s* and a distance *d* from a center of the circle to a point, such as the midpoint, of chord *c*, as shown in Fig. 5. Similarly, inner edges of each side edge portion 34, 35 can also be bowed outward from void 28, as shown in Fig. 1. Preferably, at least a portion of the inner edge of side edge portion 34 and/or 35 is bowed outward from void 28 in a direction from a top to a bottom of side edge portion 34 and/or 35. Preferably, but not necessarily, the inner edge of opposing side edge portions 34, 35 of seal 30 each is bowed outward from void 28 and follows an arc segment having a height of at least about 0.125 inch. In other embodiments, one or more of seal portions 33, 34, 35 and/or 36 can have any suitable non-linear shape or configuration.

Referring to Figs. 1 and 5, for one embodiment of a flexible container 10 having a width (from side edge to side edge) of about 6.875 inches and a length (from top to bottom) of about 11.875 inches, the radius *r* of bottom portion 33 is preferably about 8 inches in order to form bottom portion 33, having an inner edge

which bows outward from void 28 by about 0.125 inch. Further, the radius *r* of each of opposing side edge portions 34, 35 is preferably about 70 inches in order to form side edge portions 34 and/or 35, having inner edges which bow outward from void 28 by about 0.125 inch.

As shown in Fig. 3, in one preferred embodiment of this invention, the inner edge of bottom portion 33 of seal 30 has an arcuate shape and opposing side edge portions 34, 35 of seal 30 converge in a direction toward bottom portion 33. Opposing side edge portions 34, 35 can be generally linear, as shown in Fig. 3, or at least a portion of the inner edge of opposing side edge portions 34 and/or 35 can be generally non-linear, for example having an arcuate shape, as shown in Figs. 1 and 4.

Referring further to Fig. 4, in one preferred embodiment of this invention, side edge portion 34 and/or 35 can include a non-linear portion, for example having a curved or arcuate shape, as well as a linear portion. As shown in Fig. 4 for example, near closure area 62, the inner edge of opposing side edge portions 34, 35 of seal 30 diverge from each other in a direction from a bottom 37 to a top 38 of side edge portions 34, 35 in order to maximize the length of opening 60. The inner edge of opposing side edge portions 34, 35 may also include a portion which is generally linear and/or parallel to a respective side edge of flexible container 10, as shown in Fig. 4, or opposing side edge portions 34, 35 may converge in a direction toward bottom portion 33, similar to the preferred embodiment shown in Fig. 3. In

the preferred embodiments as shown in Figs. 3 and 4, flexible container 10 includes an extended or large opening 60 which provides easy access to void 28.

In one embodiment of this invention, flexible container 10 further comprises a second seal 39 positioned inward with respect to void 28, as shown in Fig. 6. Second seal 39 can be a continuous seal about at a least a portion of the periphery of flexible container 10 or can be segmented or noncontinuous, as shown in Fig. 6. Preferably, at least a portion of second seal 39 is non-linear, such as having an arcuate shape. As shown in Fig. 6, second seal 39 is bowed outward from void 28. Alternatively, second seal 39 can be generally linear and/or parallel to a respective side edge of flexible container 10. Segmented second seal 39 allows fluid materials contained within void 28 to move, flow or communicate beyond a sealing line of second seal 39 towards seal 30 formed about the flexible container periphery, while maintaining a desired void shape or configuration to distribute forces evenly along or against seal 30.

Referring to Figs. 1, 3 and 4, first web 20 forms an opening 60 at or within a closure area 62 defined by first web 20 to provide access to void 28. Preferably, but not necessarily, opening 60 comprises a slit which is positioned along, at or near a fold line 99, which passes through closure area 62, as shown in Fig. 1. Opening 60 may extend outward in a direction toward seal 30 any suitable distance. Opening 60 may stop short of seal 30, may extend up to an inner edge of seal 30, may extend into seal 30, may extend up to an outer edge of seal 30, and/or may extend

beyond seal 30 into a skirt 75. To whatever distance opening 60 extends, there should be a sufficient area of adhesive contact, either adhesive-to-adhesive or adhesive to web 20, to ensure a tight seal at or near end portions 71, 73 of opening 60 to provide a tight leak-proof seal about opening 60, particularly when flexible container 10 is folded about fold line 99. Further, as a distance between end portion 71 and/or 73 and seal 30 decrease, a width of seal 30 and/or a width of skirt 75 defined by a portion of flexible container 10 between edges 13, 15 of flexible container 10, respectively, and an outer edge of seal 30 preferably but not necessarily increases.

An adhesive layer 68 is applied to at least a portion of first web 20 at closure area 62. Any suitable adhesive known to those skilled in the art can be used to form adhesive layer 68, which provides a sufficiently strong adhesive seal to close opening 60. A cover strip 50 can be applied to or positioned on adhesive layer 68, such that adhesive layer 68 is sandwiched or positioned between first web 20 at closure area 62 and cover strip 50. Preferably, cover strip 50 and adhesive layer 68 form a pressure sensitive tape material, as is well known in the art. The pressure sensitive material can be applied as a preformed material or can be applied in manufacturing steps as adhesive layer 68 and cover strip 50.

In one preferred embodiment of this invention, at least one web 20, 40 has at least one structural relief 69. As shown in Fig. 1, structural relief 69 is formed by notched areas 70 positioned at or near end portion 71 and/or 73 of opening 60. The term "structural relief" as used throughout this specification and in the claims refers

to any structural feature or material property of any one or more layers of web 20, 40 that decreases a magnitude of the shape memory or bias force of web 20, 40. Shape memory relates to a folded web 20, 40 that urges itself back to an unfolded position or state, and is one problem associated with conventional flexible containers, and is directly related to container leakage.

In one preferred embodiment of this invention, structural relief 69 comprises a notched area 70 formed in one or more layers of web 20 and/or one or more layers of web 40 and extending a distance on one or both sides of fold line 99, as shown in Fig. 1. Notched area 70 may be formed by removing or otherwise eliminating at least one layer of first web 20 and/or second web 40 at notched area 70. Preferably, first web 20 and/or second web 40 comprises notched area 70 at or near one or both side edges 13, 15 of flexible container 10. Notched area 70 extends at least partially between outer edge 13, 15 of flexible container 10 and respective end portion 73, 71 of opening 60. Depending on the number of layers in each web 20, 40, notched area 70 can extend inward further than end portion 71 and/or 73. Further, notched area 70 may extend through only one layer or more than one layer of first web 20 and/or second web 40, and may extend laterally into a corresponding portion of seal 30.

Referring to Figs. 1 and 2, when adhesively sealing opening 60 of flexible container 10 at closure area 62, cover strip 50 is removed, for example by peeling cover strip 50 from adhesive layer 68. A top portion 12 of flexible container

10, above fold line 99, is folded to contact a bottom portion 14 of flexible container 10, below fold line 99. Preferably, to provide a tight leak-proof seal, flexible container 10 is folded along fold line 99. Adhesive layer 68 provides a leak-proof seal about opening 60 in closure area 62. In one preferred embodiment of this invention, adhesive layer 68 is positioned on top portion 12 and extends towards fold line 99 to a bottom edge 101 of adhesive layer 68, as shown in Fig. 6. When top portion 12 is folded at fold line 99 with respect to bottom portion 14, the adhesive on top portion 12 contacts an outer surface of first web 20 on bottom portion 14 to form an adhesive-to-layer bond. Depending on the design parameters and/or the intended use for flexible container 10, adhesive layer 68 can extend from top portion 12 any suitable distance toward fold line 99 and terminate either before, at or beyond fold line 99, preferably but not necessarily so that when folded, adhesive layer 68 fully surrounds opening 60 to completely seal opening 60. In one preferred embodiment of this invention as shown in Fig. 1, at least one structural relief 69, for example notched area 70 is formed in first web 20 and/or second web 40 by preferably, but not necessarily, removing or otherwise eliminating, such as through a manufacturing process, a portion of at least one layer of first web 20 and/or at least one layer of web 40. Preferably, fold line 99 passes through notched area 70. Fold line 99 defines the longitudinal position of opening 60 with respect to flexible container 10.

In one embodiment of this invention, when flexible container 10 is folded about fold line 99, adhesive layer 68 folds over onto itself to form an adhesive-

to-adhesive bond and/or folds over onto an outer surface of first web 20 to form an adhesive-to-layer bond. In either case, because of the shape memory or bias force within the layer at fold line 99 the layer has a tendency to unfold or open flat. By applying more pressure to the layer at fold line 99, the adhesive-to-adhesive and/or the adhesive-to-layer bond strength is increased. Providing one or more notched areas 70 at fold line 99 allows more direct pressure applied at fold line 99 which enhances the bond strength provided by adhesive layer 68 and reduces the shape memory as well.

While in the foregoing specification the invention has been described in relation to certain preferred embodiments, and many details are set forth for purpose of illustration, it will be apparent to those skilled in the art that the invention is susceptible to additional embodiments and that certain of the details described in the specification and in the claims can be varied considerably without departing from the basic principles of the invention.